§54. Injection and Transport Study of High Z Noble Gases

Funaba, H., Sato, K., Kato, T., Ohdachi, S.,
LHD Experimental Group

Heavy noble gases such as krypton (Kr) or xenon (Xe) are considered to be able to simulate the behavior of metal impurities from the wall in the fusion plasma devices due to their recycling. The line emission from their highly ionized ions may be used for the impurity transport analysis at the central region of the main plasma by comparing with the calculation results of the one dimensional impurity transport code, MIST [1]. In the Large Helical Device (LHD), Kr and Xe was injected into the hydrogen or helium plasmas through the gas-puff system at the 5.5L port. The main purpose of the recent experiments was to obtain spectra of Kr and Xe. The emission lines from them in the VUV regime were observed by the Schwob-Fraenkel type spectrometer.

Spectra from the Kr injected plasmas were obtained with a grating of 133.6 gr/mm in the wavelength region of 50 $\sim$ 310 Å and 610 $\sim$ 1500 Å by changing the central wavelength of the spectrometer. Three strong lines appeared after the Kr injection and they are identified as the emission from KrXXVI (159.9, 179.0 and 220.0 Å). Figure 1 shows two of them and the strong line at 303.78 Å of HeII. The charge state densities of Kr are calculated by MIST. When the electron temperature at the center, $T_e(0)$, is 2.85 keV, KrXXVI mainly exists in the region of $0.7 < \rho < 0.8$, where ρ is the normalized minor radius. The dominant ionization states of Kr at the center are KrXXIX and KrXXX. Moreover, the behavior of the radiation from the core region are investigated by using the soft X-ray signals, which increased after the Kr injection (Fig. 2).

Xeon was injected into the LHD plasmas for the first time in the last experimental campaign. The spectra were obtained from 10 Å to 340 Å with a 600 gr/mm grating. A long exposure time of 1 sec. was chosen in these experiments in order to search Xe lines. So the electron temperature and density changed during one frame of the spectra. The prominent lines around 110 Å, which are shown in Fig. 3, and some lines around 130 Å in this wavelength region are considered to be mainly from lower charge states of Xe. According to the MIST calculation, the dominant ion species at the center is Xe^{36+} with $T_e(0) = 2.85$ keV. Therefore, it is important to distinguish the lines from charge states higher than XeXXV for the impurity transport study in the core plasmas. In the next experimental campaign, the VUV measurement with more detailed temporal and spatial resolution is planned in order to identify lines from each charge state.

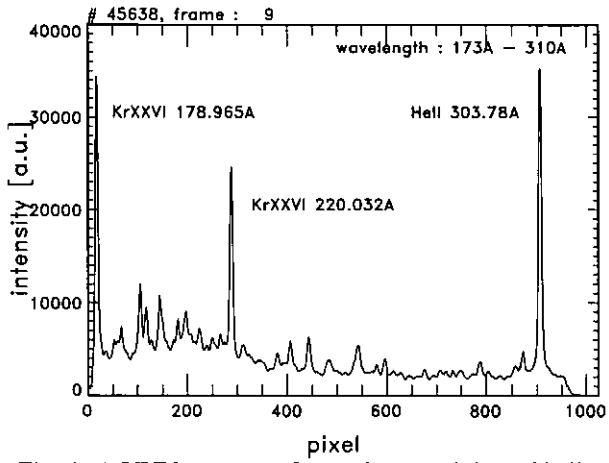

Fig. 1. A VUV spectrum from a krypton injected helium plasma on LHD.

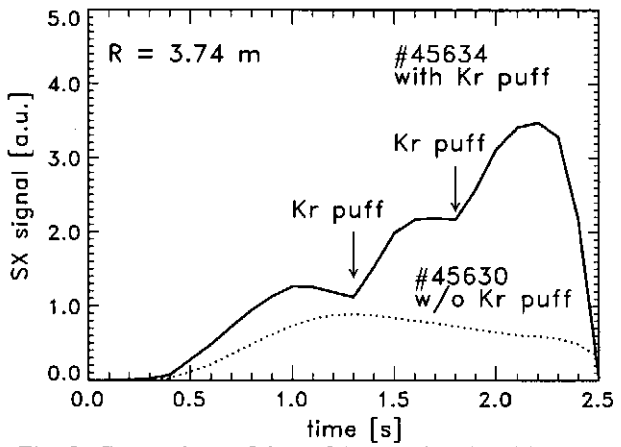

Fig. 2. Comparison of the soft X-ray signals with and without Kr puff.

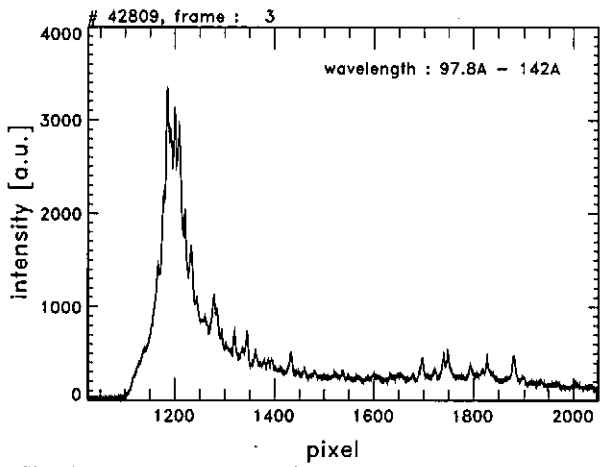

Fig. 3. A VUV spectrum from a xenon injected plasma on LHD.

Reference

1) R.A.Hulse, Nucl.Tech./Fusion 3(1983)259.